New insights in diagnostic and therapeutic maneuvers for BPPV

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Summary

BPPV is amongst the most common causes of vertigo caused by migration of otoconial debris into the semicircular canals, rendering them sensitive to head motion. As a mechanical inner ear disorder, the movement of the debris stimulate the hair cells in the affected semicircular canal resulting in a feeling of spinning with generation of nystagmus. Chapter 2 describes the anatomy and physiology of the vestibular labyrinth clinically relevant to BPPV.

BPPV is treated by performing repositioning maneuvers to bring the otolith debris out of the involved canal back to the utricle. However, it is often difficult for the clinician to be able to visualize the three-dimensional orientation of the head in relation to the semicircular canals to be able to understand how best to treat different kinds of BPPV. In view of this drawback, a 3D simulation model of the vestibular labyrinth was created for a more comprehensive understanding of BPPV. Chapter 3 discusses the steps of the development of this 3D model. The simulations provide a valuable and accurate representation of many aspects of the inner ear and serve as a powerful tool in enhancing our understanding and management of the balance disorders. The simulation model provides a useful tool to visualize the three-dimensional structure of the semicircular canals. It allows the viewer to see the effect of gravity on the debris present in all the canals and at different positions within the canals as well. Chapter 4 shows how the plane and angle at each step of the repositioning maneuver is important to make the treatment a success or failure. Showing the example of Semont's maneuver in the form of a simulation allows the clinician to understand how the otolith crystals move at each step. The simulation of Semont's Plus maneuver which extends the head and neck by an additional 30° , allows the debris to move further through the posterior canal crossing the apical turn. This additional angulation has two advantages. First, it ensures that the debris does not fall back towards the ampulla. The Semont's maneuver is dependent on gravity and inertia to move the debris and hence requires a brisk swinging of the trunk to the opposite side. The Semont's Plus maneuver requires only the effect of gravity to move the debris and hence does not require a fast swinging. This is a distinct advantage in patients where fast movement is difficult like pregnant women, obesity, spinal problems, etc.

Different debris positions within the canal will generate different nystagmus patterns. Chapters 4 and 5 describe the different debris positions within the posterior and horizontal canal where BPPV will generate different kinds of nystagmus, for example, long arm posterior canal generates torsional upbeat nystagmus while non-ampullary arm posterior canal BPPV generates down beating nystagmus on the Dix-Hallpike test. The clinical implication of recognition of the nystagmus is to choose the maneuver best suited to reposition the crystals out of the canal.

Chapter 5 demonstrates the nystagmus generated in horizontal canal BPPV in the simulations by linking the canals with the oculomotor muscles in the software, following Ewald's Laws and the principles of gravity. Simulations of Roll maneuver and Zuma maneuver demonstrate that both these maneuvers are useful in repositioning of debris in canalithiasis involving the ampullary and non-ampullary arms. The Gufoni maneuver simulation showed successful repositioning of canalithiasis of the non-ampullary arm. However, the simulation of Gufoni maneuver for ampullary arm showed failure of repositioning. Simulation of Appiani modification of Gufoni maneuver also showed incomplete repositioning of debris from the ampullary arm of the horizontal canal.

Anterior canal BPPV is less common due to the anti-gravity position of the canal. Chapter 6 shows simulations of diagnostic tests and treatment maneuvers for ac-BPPV. It is a common finding to see reversal of nystagmus when performing the Dix-Hallpike test when the patient is brought back to the sitting position. Simulations in Chapter 4 show that this is because of the otolith debris falling back towards the ampulla. In contrast to this finding of Dix-Hallpike test, the Supine Head hanging (SSH) test does not show reversal of nystagmus when the patient is brought back to the sitting position. The simulation of SSH shows that the debris moves in the same direction further through the anterior canal on coming back to the sitting position. This chapter also describes a modification of the Yacovino maneuver used to treat ac-BPPV making the maneuver simpler and also reducing the chance of canal switch. This modification omits the chin-to-chest position in the Yacovino maneuver and brings the patient back to the sitting position.

The Supine Roll test is considered to be the gold standard test for diagnosis of horizontal canal BPPV. Simulations show that this test has an 'Observer Effect' meaning that the actual test can influence the result of the test by causing movement of the debris from their original position. Chapter 7 shows that the order in which the test is performed, whether starting from the right or left, will have an impact on the type of nystagmus seen. Different kinds of nystagmus patterns seen on the supine roll test have been described in Chapter 7 along with simulations to show how the debris is being displaced. This allows the clinician to understand the pathophysiology of direction-changing, direction-fixed and unilateral nystagmus. This chapter also extols the need for a standardized testing protocol for BPPV to enable global uniformity and comparability in results.

Maneuvers used for the treatment of BPPV are based on taking the head into the plane of the involved semicircular canal and then moving the head in the direction to facilitate movement of the otolith debris out of the canal. Incorrectly performed maneuvers may reduce their efficacy. A guidance system to assist in performing repositioning maneuvers has been described in Chapter 8. The guidance system provides visual feedback to the clinician showing the actual head position and desired head position at each step of the maneuver. This would help in reducing variability in performance of the maneuvers and also help clinicians who do not treat BPPV routinely.

Though BPPV is such a common cause of dizziness, there are still many unknowns in our understanding disorder. Simulations have helped us understand BPPV in the three-dimensional space. The simulations can help in improving existing testing and treating maneuvers as well as help in development of new treatment options.